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Competition, external economies of scale and unionized wage [†]

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Abstract: We provide a rationale for the mixed relationship between product market competition and unionized wage, and more importantly, for a generally unexplained empirical evidence of a positive relationship between product market competition and unionized wage. We show that a higher product market competition decreases (increases) unionized wage if the external scale economies is weak (strong). However, a higher product market competition may decrease or increase the unionized wage if the external scale economies is moderate.

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1. Introduction

Does increased product market competition make workers worse off by reducing unionized wage? The evidence is mixed. Connolly et al. (1986), Hirsch and Link (1987), Audretsch and Graf von der Schulenburg (1990) show that the effect of competition on unionized wage is negative. On the other hand, Bloch and Kuskin (1978) and Freeman and Medoff (1981) found that increased competition increases unionized wage. Abowd and Tracy (1989) show that the relationship between four firm concentration of sales and unionized wage is positive at high levels of competition but it is negative at low levels of competition. Stewart (1990), Macpherson and Stewart (1990) and Van Reenen (1996) report mixed evidences.

We provide an explanation for the mixed evidence. Considering firm-level union-firm wage bargaining, as in Dowrick (1989) and Naylor (2002a, b), we show that increased product market competition may increase or decrease unionized wage depending on the strength of external economies of scale that affects labor productivities.[1] If the strength of external economies of scale is weak (strong), a higher competition always decreases (increases) unionized wage. However, if the strength of external economies of scale is moderate, a higher competition may decrease or increase unionized wage depending on market concentration. Our results can explain the

[1] There are at least two ways through which external economies of scale may affect labor productivities. First, if the labor productivity depends on multiple aspects of the production process and different firms have advantages in different aspects of the production process, knowledge spillover within the industry helps all firms to benefit from each other's expertise, which, in turn, increases labor productivity when the number of firms rises in the industry. Second, "learning-by-doing" at the industry level might increase labor productivity. Increased product market competition increases total output in the industry, which can create industry wide learning-by-doing and benefit all firms in the presence of knowledge spillover. For the analytical ease, we however, rely on the first reason for our modelling purposes. This notion of external economies comes from Marshall (1890) and has been discussed in many other papers (see, e.g., Griliches, 1992 and Audretsch et al., 2007).

empirical findings of Abowd and Tracy (1989), where the relationship between market concentration and unionized wage is positive at high levels of competition but it is negative at low levels of competition.

Our results are driven by two opposing effects. First, analogous to Dowrick (1989), and Naylor (2002a, b), an increased competition creates the *business stealing effect* that tends to moderate labor demand and the unionized wage. We call this as "competition effect". Second, the presence of external economies of scale creates a *business creation effect* by increasing productivities of the final goods producers, which tends to increase labor demand and the unionized wage. We call this as "scale effect". Increased product market competition results in higher (lower) unionized wage when the scale effect dominates (is dominated by) the competition effect.

Although a relatively strong scale effect increases the unionized wage following increased product market competition, it is not immediate whether the positive relationship holds in a more concentrated industry or in a less concentrated industry. We discuss the situations when an increased competition in the final goods market increases the unionized wage in a more concentrated industry and in a less concentrated industry. Thus, we show the conditions when the empirical findings of Abowd and Tracy (1989) hold true.

The existing theoretical literature on this issue is also mixed. Considering a monopolist input supplier and specific demand functions for the final goods, Greenhut and Ohta (1976) and Corbett and Karmarkar (2001) show that the equilibrium input price is invariant to the number of final goods producers. Tyagi (1999) considers a general demand function for the final goods and shows that the above-mentioned invariance result holds if the inverse demand function is not very convex. However, the input price increases for highly convex demand functions. Koulamas and Kyparisis

(2010) show that this invariance result does not hold in the presence of external economies of scale in the product market. In contrast to these papers, we consider firm-specific wage bargaining between labor unions and firms.

Dowrick (1989) and Naylor (2002a, b) considered firm-specific wage bargaining between labor unions and firms and showed that increased product market competition reduces the unionized wage.[2] We show that this result may not hold true in the presence of external economies of scale in the product market.

Considering a move from monopoly to duopoly, Bastos et al. (2010) show the positive relationship between product market competition and unionized wage under open shop union, where the union density is less than one. Mukherjee (2012) generalizes Bastos et al. (2010) with multiple unionized and non-unionized firms and shows that the result of Bastos et al. (2010) is very sensitive to their assumption of initial monopoly, and their result does not hold if the initial market structure is duopoly with at least one of them is unionized.[3] In contrast to these papers, we show the positive relationship between product market competition and unionized wage under a closed shop union where all workers are union members.

The remainder of the paper proceeds as follows. Section 2 describes the model and shows the results. Section 3 concludes.

2. The model and the results

We adopt a partial equilibrium analysis with Leontief technologies.[4] Consider an industry with $n > 1$ quantity setting firms. We assume for simplicity that production

[2] In different contexts, this wage moderation effect is also shown in Mukherjee et al. (2008 and 2009).
[3] In open shop unions, Corneo (1993) shows that higher product price reduces unionized wage when social custom effects are strong.
[4] Note that a general equilibrium analysis, in this context, is also an important aspect to consider. However, a partial equilibrium analysis allows us to show the implications of external economies of scale

requires only workers which the firms get from firm-specific labor unions. The wages are determined by Nash bargaining between the firms and the firm-specific labor unions.

The production technology is such that each firm requires λ workers to produce one unit of output which gives its productivity equal to $\frac{1}{\lambda}$. We assume that the firms operate under external economies of scale such that their productivities increase with increased competition in the product market. In other words, an increased competition in the product market reduces each final goods producer's requirement for workers.[5] Assume that $\lambda = \lambda(n)$ with $\frac{\partial \lambda}{\partial n} \equiv \lambda' < 0$ and $\frac{\partial^2 \lambda}{\partial n^2} \equiv \lambda'' > 0$, i.e., an increase in n reduces the need for workers at a decreasing rate. The assumption of $\lambda'' > 0$, which may seem reasonable, is not necessary for our results, but it helps to show our results in the simplest way. For a clear exposition, we assume that $\lambda(n) = \frac{1}{(1+n)^{\alpha}}$, i.e., productivity is $\frac{1}{\lambda(n)} = (1+n)^{\alpha}$, where $\alpha > 0$. This specification is a special case of a functional form $\lambda(n) = \frac{1}{(b+n)^{\alpha}}$, with $b = 1$. We will later discuss the implications of $b \neq 1$. As α increases, the strength of external economies of scale increases. In the following analysis, we will discuss how increased competition affects equilibrium unionized wage for different values of α.

only by making our framework otherwise comparable to the existing literature. Similarly, the adoption of Leontief technology makes our results comparable to the cited literature.

[5] As mentioned in footnote 1, knowledge spillover helps firms to learn from each other, which helps to increase their productivities. As more firms enter the market, the benefits from knowledge spillover increase. Here we assume that knowledge spillover helps all firms symmetrically.

We consider the following game. At stage 1, the firms and the labor unions bargain over wages, w_i. At stage 2, the firms compete in outputs and maximize their respective profits. We solve the game through backward induction.

Assume that the inverse market demand function is $P = a - q$, where P denotes price and q represents the total output. As mentioned by Corbett and Karmakar (2001), this may also be considered as the linear approximation of the actual demand.

We start our discussion at stage 2 where a representative firm maximizes the following profit expression to determine its own output:

$$\underset{q_i}{Max}\ \pi_i^D = (a - q - \lambda w_i) q_i \tag{1}$$

We obtain the equilibrium output of the *i*th firm as:

$$q_i = \frac{1}{n+1}\left[a - n\lambda w_i + \sum_{\substack{j=1 \\ j \neq i}}^{n} \lambda w_j \right] \tag{2}$$

Next, we consider the wage setting stage. Assume that the *i*th labor union's utility takes the following form[6]

$$\pi_i^U = (w_i)(\lambda q_i). \tag{3}$$

We assume that the equilibrium wage is the outcome of a Nash bargaining process and is derived by maximizing the following expression:

$$\underset{w_i}{Max}\ \left(\pi_i^U - \overline{\pi}_i^U\right)\left(\pi_i^D - \overline{\pi}_i^D\right) \tag{4}$$

where $\overline{\pi}_i^U$ and $\overline{\pi}_i^D$ are the disagreement pay-offs of the labor union and the firms respectively. In our structure, where the labor unions are specific to firms and all workers are union members, there will be no production in the event of union-firm

[6] Without any loss of generality, we set the reservation wage equal zero as this does not add any new insights to our work. Needless to say that the qualitative results of our paper still hold for a positive reservation wage.

disagreement. This entails zero reservation pay-offs for both the concerned labor union and the firm, i.e., $\bar{\pi}_i^U = \bar{\pi}_i^D = 0$.

Maximizing (4) with $\bar{\pi}_i^U = \bar{\pi}_i^D = 0$ gives the equilibrium wage as

$$w_i^* = \frac{1}{\lambda}\left[\frac{a}{1+3n}\right] = \frac{a(1+n)^{\alpha}}{(1+3n)}, \tag{5}$$

since $\frac{1}{\lambda} = (1+n)^{\alpha}$, as mentioned above.

It follows from the first equality in (5) that in the absence of external economies of scale, i.e., if λ is independent of *n*, there exists an inverse relationship between increased competition in the final goods market and the equilibrium wage. However, in the presence of external economies of scale, increased competition in the final goods market increases the firms' productivities which create a counterforce and tend to raise the equilibrium wage.

Proposition 1: *(i) If* $0 < \alpha \leq 1$*, higher competition in the product market decreases the equilibrium unionized wage for* $n > 1$.

(ii) If $1 < \alpha \leq \frac{3}{2}$*, higher competition decreases (increases) the equilibrium unionized wage for* $n < (>) n^*$*, where* $n^* = \frac{3-\alpha}{3(\alpha-1)} > 1$ *for* $1 < \alpha \leq \frac{3}{2}$.

(iii) If $\frac{3}{2} < \alpha$*, higher competition increases the equilibrium unionized wage for* $n > 1$.

Proof: Differentiating (5) with respect to *n*, we get

$$\frac{\partial w^*}{\partial n} = \frac{a(1+n)^{-1+\alpha}\left((\alpha-3)+3n(\alpha-1)\right)}{(1+3n)^2}. \tag{6}$$

Hence, $\frac{\partial w^*}{\partial n} > (<) 0$ if $(\alpha-3)+3n(\alpha-1) > (<) 0$.

If $0<\alpha\le 1$, we get $(\alpha-3)+3n(\alpha-1)<0$, implying $\frac{\partial w^*}{\partial n}<0$ for $n>1$.

On the other hand, if $\frac{3}{2}<\alpha$, we get $(\alpha-3)+3n(\alpha-1)>0$ for $n>1$, implying $\frac{\partial w^*}{\partial n}>0$ for $n>1$.

If $1<\alpha\le\frac{3}{2}$, we get $(\alpha-3)+3n(\alpha-1)<(>)0$ for $n<(>)\frac{3-\alpha}{3(\alpha-1)}\equiv n^*$, where $n^*>1$ for $1<\alpha\le\frac{3}{2}$. Hence, if $1<\alpha\le\frac{3}{2}$, we get $\frac{\partial w^*}{\partial n}<(>)0$ for $n<(>)n^*$. ■

The reasoning behind the above proposition hinges upon two factors. First, an increase in the number of firms creates a *business stealing effect* by reducing the market share of each final goods producer, which, in turn, reduces the input demand and tends to reduce the wage. We call this a "competition effect". Secondly, external economies of scale creates a *business creation effect* by increasing productivities of the final goods producers, which tends to increase labor demand and wage. We call this a "scale effect". If this "scale effect" is sufficiently strong, it dominates the competition effect and consequently, the equilibrium wage increases with increased product market competition. The reverse holds true when the scale effect is weak.

Proposition 1(i) shows that if the external scale economies is weak, the competition effect is the dominant factor for any number of firms and a higher competition always deceases the unionized wage. On the other hand, Proposition 1(iii) shows that if the external scale economies is strong, the scale effect is the dominant factor for any number of firms and a higher competition always increases the unionized wage. Proposition 1(ii) shows the case of moderate external scale economies. In this

situation, large (small) number of firms makes the scale effect stronger (weaker) than the competition effect.

Figure 1 shows the results in Proposition 1 by plotting $G=(\alpha-3)+3n(\alpha-1)$ for $\alpha=0.5$, $\alpha=1.2$, $\alpha=2$ and $n\in[1,5]$.

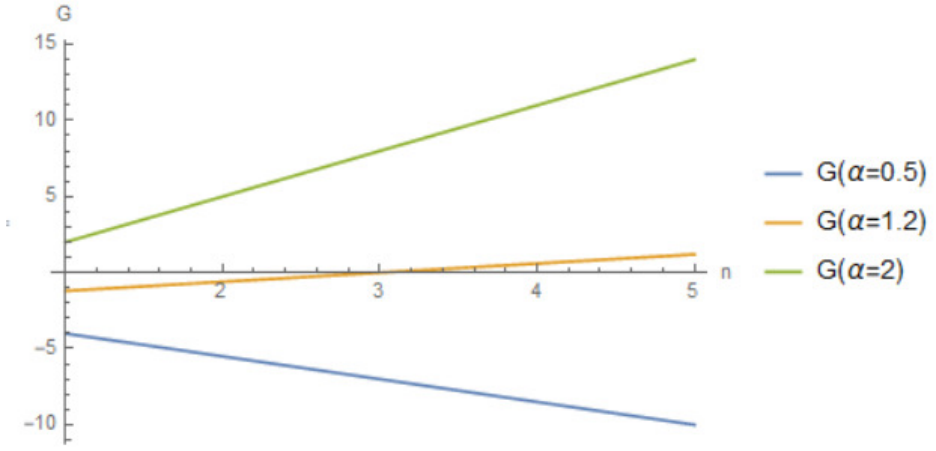

Figure 1: $G=(\alpha-3)+3n(\alpha-1)$ for $\alpha=0.5$, $\alpha=1.2$, $\alpha=2$ and $n\in[1,5]$

We have derived Proposition 1 for $\lambda(n)=\frac{1}{(b+n)^{\alpha}}$ with $b = 1$. We have shown in Proposition 1 that depending on α, a higher competition may always increase the unionized wage, always decrease the unionized wage or can increase the wage if the number of firms is large, i.e., competition is strong. We will now show that there can be values of b such that a higher competition can increase the unionized wage if competition is weak.

For $b>0$, we find $w_i^*=\frac{a(b+n)^{\alpha}}{(1+3n)}$ and $\frac{\partial w^*}{\partial n}=\frac{a(b+n)^{-1+\alpha}\left((\alpha-3b)+3n(\alpha-1)\right)}{(1+3n)^2}$. The sign of $\frac{\partial w^*}{\partial n}$ depends on the sign of

$(\alpha-3b)+3n(\alpha-1)$. The inspection of $(\alpha-3b)+3n(\alpha-1)$ suggests that this is linear in *n*, and can be negative (positive) for low values of $n(\geq 1)$ but positive (negative) for high values of *n* provided $(\alpha-3b)<0<(\alpha-1)$ ($(\alpha-1)<0<(\alpha-3b)$), i.e., $b>\frac{1}{3}$ ($b<\frac{1}{3}$). Proposition 1 considered *b = 1*, i.e., a case of $b>\frac{1}{3}$.

Now we want to consider a case of $b<\frac{1}{3}$ to show that there can be a situation where a higher competition increases the unionized wage if competition is low. To do this, assume that *b = 0*.

If $b=0$, we get $\frac{\partial w^*}{\partial n}<(>)0$ for $\alpha+3n(\alpha-1)<(>)0$. If $\alpha\leq\frac{3}{4}$, we get $\alpha+3n(\alpha-1)<0$ for $n>1$, implying $\frac{\partial w^*}{\partial n}<0$ for $n>1$. On the other hand, if $\alpha\geq 1$, we get $\alpha+3n(\alpha-1)>0$ for $n>1$, implying $\frac{\partial w^*}{\partial n}>0$ for $n>1$. If $\frac{3}{4}<\alpha<1$, we get $\alpha+3n(\alpha-1)<(>)0$ for $n>(<)\frac{\alpha}{3(1-\alpha)}\equiv n^{**}$, where $n^{**}>1$ for $\frac{3}{4}<\alpha<1$, implying $\frac{\partial w^*}{\partial n}<(>)0$ for $n>(<)n^{**}$.

Hence, unlike Proposition 1(ii), we find here that if the strength of external scale economies is moderate, i.e., $\frac{3}{4}<\alpha<1$, a higher competition increases the unionized wage if competition is low. The reason for this as follows. Since $\frac{\partial\left(\frac{1}{\lambda}\right)}{\partial n}=\frac{\alpha}{(b+n)^{1-\alpha}}$, higher competition increases labor productivity more for lower values of *b* and *n* when $\alpha<1$, implying that the gain from external economies of scale is higher for lower

values of b and n when $\alpha<1$. Further, since $\frac{\partial^2\left(\frac{1}{\lambda}\right)}{\partial n^2}=-\frac{\alpha(1-\alpha)}{(b+n)^{2-\alpha}}$ and $\left|\frac{\partial^2\left(\frac{1}{\lambda}\right)}{\partial n^2}\right|=\frac{\alpha(1-\alpha)}{(b+n)^{2-\alpha}}$ increases with lower values of b, the gain from external economies of scale reduces with n at a higher rate for lower values of b. Therefore, if b is low, it is possible to have a situation where the scale effect dominates the competition effect for a lower n but as n increases, the gain from external economies of scale reduces significantly to make the competition effect stronger than the scale effect.

Figure 2 shows the case of $b = 0$ and plots $H=\alpha+3n(\alpha-1)$ for $\alpha=0.5$, $\alpha=0.88$, $\alpha=2$ and $n\in[1,5]$.

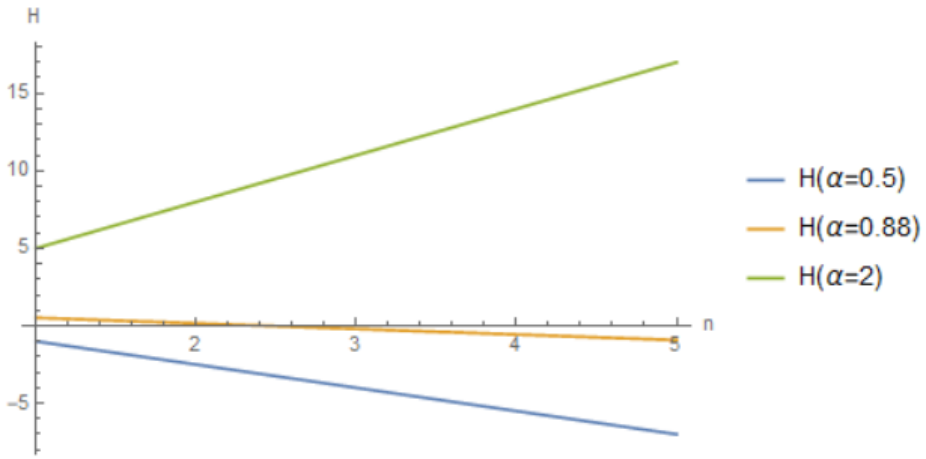

Figure 2: $H=\alpha+3n(\alpha-1)$ for $\alpha=0.5$, $\alpha=0.88$, $\alpha=2$ and $n\in[1,5]$

If the strength of external economies of scale is weak (strong), i.e., α is low (high), a higher competition decreases (increases) the unionized wage irrespective of the value of b. Thus, these situations explain the empirical evidences of wage reducing competition (see, e.g., Connolly et al., 1986, Hirsch and Link, 1987 and Audretsch and

Graf von der Schulenburg, 1990) and wage raising competition (see, e.g., Bloch and Kuskin, 1978 and Freeman and Medoff, 1981) respectively. However, the evidence found by Abowd and Tracy (1989), where the relationship between market concentration and unionized wage is positive at high levels of competition but it is negative at low levels of competition, can be explained by Proposition 1(ii).

3. Conclusion

We provide a theoretical explanation for the mixed relationship between product market competition and unionized wage, and more importantly, for a generally unexplained empirical evidence of a positive relationship between product market competition and unionized wage. Our explanation is based on the externalities created by external of economies of scale. We show that a higher product market competition decreases (increases) unionized wage if the external scale economies is weak (strong). However, a higher product market competition may decrease or increase the unionized wage if the external scale economies is moderate.

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